Hydrodynamics Experiments Study Material Properties – January 2004

The primary mission the National Ignition Facility is to provide data to support our nation's stockpile stewardship program, including fusion ignition. At the end of January the Hydrodynamics Integrated Experimental Team began the first NIF experiments to study the properties of materials under extreme conditions.

The hydrodynamics experiments utilize NIF's laser energy to produce shock waves in materials. Recording the propagation of shock waves through materials is key to validating computer models that predict how materials react when subjected to extreme conditions.

Setup

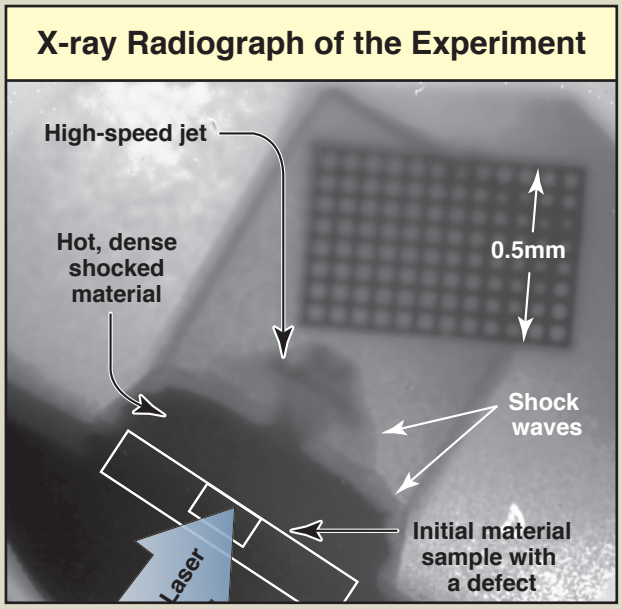
For the initial experiments, a material sample is positioned at the target chamber. Powerful laser pulses strike the material, generating intense shock waves that flow from the sample. Nanoseconds later, another beam strikes a point source behind the sample, generating x-rays that illuminate or "backlight" the target. This allows sophisticated x-ray imaging cameras to record the shock propagation. The shock waves reach millions atmospheres of pressures and material sample attains temperatures of tens of thousands of degrees.

Instabilities

When the beams strike a sample whose surface is uniform, the resulting shock wave is essentially uniform. However, a defect on the material surface produces vastly different results. Shock waves of different densities and speeds propagate from the irregular material surface, generating unstable plasma flows and instabilities between shock interfaces. High-speed jets exceed 100,000 miles per hour, causing turbulent flow and mixing between the interfaces.

Results

The first NIF hydrodynamics experiments have produced empirical shock data relevant to our national Stockpile Stewardship Program. Near-term hydrodynamics experiments will be used to benchmark computer tools that predict the evolution of materials exposed to extraordinary temperatures and pressures. Longer-term experiments will uniquely address—for the first time ever in a controlled laboratory setting—the large-scale hydrodynamic instabilities observed in blast waves and supernovae explosions and remnants.



Experimental results from the first NIF hydrodynamic experiments. This radiograph shows emanating shock fronts from a material sample struck with two NIF beams. The data will validate computer models that predict the behavior of materials under extreme conditions.

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